Wilderness Air Quality Value (WAQV) Class 2 Monitoring Plan
Absaroka Beartooth Wilderness
Lee Metcalf Wilderness
Gallatin, Custer, Beaverhead, Shoshone NF, Butte District BLM
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March 30, 2007

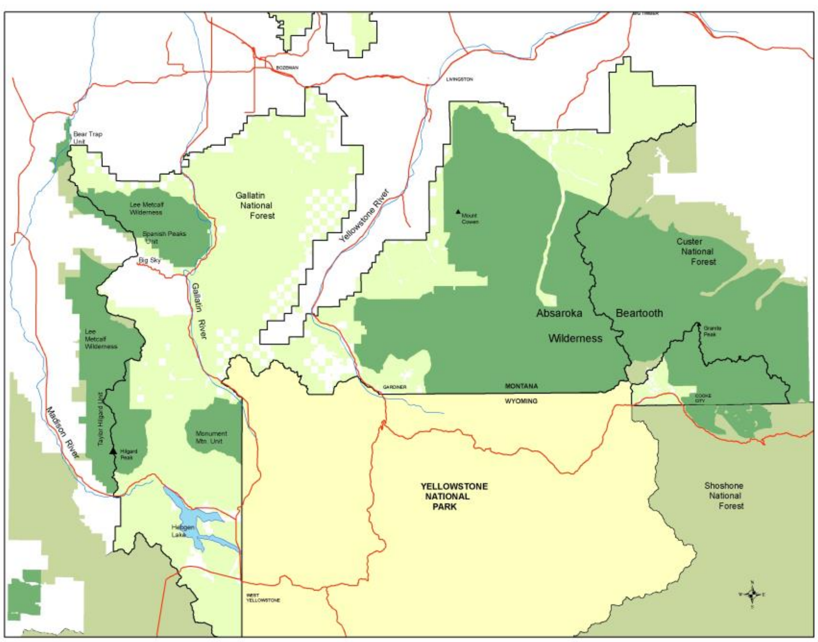
This Wilderness Air Quality Value (WAQV) Class 2 Plan was prepared to:

1. Summarize the wilderness characteristics of the Absaroka Beartooth (ABW) and Lee Metcalf Wilderness (LMW).
2. Explain the legal framework for air quality protection,
3. Identify wilderness air quality values, and
4. Provide a monitoring plan for Wilderness Air Quality Values (WAQV's).

The ABW and LMW are Class 2 for the Clean Air Act Prevention of Significant Deterioration (PSD) regulations. Air quality protection authority (beyond ambient air quality standards and PSD increments) for this wilderness area therefore relies primarily upon the Wilderness Act, although the adjacent Yellowstone NP and North Absaroka Class I Airsheds provide some defacto air quality. This plan is designed to specify appropriate monitoring to protect the Class 2 WAQV's and to meet the Wilderness Stewardship Challenge to achieve the objectives of the Air Element #3 http://www.wilderness.net/index.cfm?fuse=toolboxes&sec=air

1) Location

The Absaroka Beartooth Wilderness (ABW) is located in south central Montana (Gallatin and Custer NF's) with a small portion in northern Wyoming (Shoshone NF), just north and east of Yellowstone National Park. The ABW is a contiguous unit of 943,626 acres with 23,288 acres in Wyoming. The ABW includes the 12,799 feet Granite Peak, the highest point in Montana.



The 254,288 acre Lee Metcalf Wilderness (LMW) was designated by Congress on 10/21/1983 (PL 98-140) and is managed by the Gallatin and Beaverhead NFs and the Bureau of Land management (BLM). The LMW is just north and west of YNP and runs along most of the length of the Madison Range. The LMW consists of 4 separate units which are linked by trail.

- The Monument Mountain Unit of the LMW abuts the northwest boundary of Yellowstone National Park. It is an isolated piece rich in wildlife, including a large population of grizzly bears. All 30,000-plus acres lie within Gallatin National Forest.
- The 78,000-acre Spanish Peaks Unit encompasses steeply rugged, glaciated peaks rising more than 11,000 feet above scenic cirques and gemlike lakes. This heavily used area is popular with both local and regional visitors with a well developed trail system about 110 miles long.
- At 141,000 acres, the Taylor-Hilgard Unit is the largest unit of the Lee Metcalf. It runs along the crest of the Madison Range, with several peaks over 11,000 feet above the Hilgard Basin. Numerous meadows and lakes are surrounded by snowcapped summits.
- The BLM manages the 6,447 acre Bear Trap Canyon Unit, a stretch of wild, low elevation canyon country along the Madison River. Beartrap Canyon was the BLM's first designated Wilderness.

The ABW and LMW are guided by Management Direction in the Gallatin, Custer, Beaverhead-Deerlodge Forest plans which is being updated by Opportunity Class/Management Areas (USFS, 2006).

2) Wilderness Characteristics

Absaroka Beartooth Wilderness

The Beartooth Primitive Area (225,855 acres) and the Absaroka Primitive Area (64,000 acres) plus a considerable amount of roadless lands surrounding these two areas now form the ABW. The primitive areas were originally set aside during 1932.

Stepping Stone Lake in the Absaroka Beartooth Wilderness

The Absaroka-Beartooth Wilderness was designated on March 27, 1978 (PL 95-249). Inclusion of the Absaroka-Beartooths in the National Wilderness Preservation System was a long time effort of the late U.S. Senator Lee Metcalf (D-Montana), who introduced the original bill and was its primary advocate. Metcalf died January 12, 1978, less than three months before his goal was realized.

The ABW contains two distinctly different mountain ranges. The western section is primarily the Montana Absarokas characterized by stratified volcanic and metamorphic rocks, forested valleys and rugged peaks. The Montana Absarokas form a chain of mountains that includes the spectacular peaks east of the Paradise Valley between Livingston and Gardiner, the northeastern corner of YNP, and Pilot and Index Peaks south of Cooke City.

The eastern side of the wilderness is dominated by the high granitic plateaus of the Beartooth Mountains. Hundreds of lakes lie among the bald rock and alpine tundra of the plateaus. This country is stark, scenic, and fragile.   The high plateaus draining into the Clark Fork and deep glaciated valleys of the forks of Rosebud and Rock Creeks comprise the east unit while the rest of the wilderness is in the west unit.

The ABW has substantial populations of bighorn sheep, mountain goat, moose, elk, and black and grizzly bears. The forested valleys of the Absarokas support most species of large game animals including deer, elk and moose. The high barren ridges of the Beartooths support relatively little wildlife, with pika mountain goats, Golden eagles, falcons, and hawks.

Trout have been introduced in many of the lakes. Some now provide fishing for cutthroat, rainbow, and brook trout. Some lakes have very large fish, but most produce trout of the pan-sized variety due to short growing seasons and extremely cold water. In the Absarokas, several streams support native cutthroat populations. Five of the larger lakes also contain cutthroat. Fishing in the Beartooths is limited almost exclusively to the high Mountain lakes.

The ABW includes a wide range of vegetation zones which are influenced by elevation and local climate. At lower elevations from 6,000 feet to treeline, broad grass-sage meadows alternate with deep coniferous forest. Lodgepole pine, Engelmann spruce, subalpine fir, and Douglas fir are common at mid elevations while whitebark is dominant at high elevations to treeline. Wildflowers abound in the lower meadows throughout the summer and into the fall.

Treeline occurs between 9,000 and 9,500 feet in most areas. Above the krummholtz (the dwarf form that trees adopt at high elevations) is a windswept world of alpine tundra. Vegetation, a myriad of dwarf wild flowers, lichens, and shrubs, is low to the ground and adapted to take advantage of pockets of warmth and moisture in the rocks.

The ABW is a geological showcase of contrasting rock types, glaciation, and active land movement. The Beartooth Mountains are composed primarily of Precambrian granite and gneiss. This granite/gneiss has been uplifted and exposed, forming broad, gently sloping plateaus that rise to over 12,000 feet above sea level. Granite Peak at 12,199 feet, is the highest mountain in Montana.

The crest of the Asbaroka Beartooth Wilderness includes multiple peaks over 12,000 feet in elevation and numerous high elevation lakes which are key Wilderness Air Quality values. Courtesy of Google Earth – Europe Technologies.

The Absarokas are dominated by younger stratified Tertiary volcanic rocks. Glaciation has carved the mountains into deep U-shaped vegetated valleys with serrated ridges. Remnant alpine glaciers remain on the Beartooth crest. Parallel grooves, or striations, on rocks mark the grinding passage of ancient glaciers.

The peaks in the Montana Absarokas are not as high as the Beartooths. Mt. Cowan is the highest at 11,206 feet. Almost all of the Absaroka mountains have some of vegetative cover except for the very highest peaks and ridges. Arctic tundra plateaus such as Beartooth and Hellroaring provide a unique, but extremely fragile, ecosystem. Most of the vegetation can be found around lakes and along stream courses, or in the few small parks situated in the lower areas. Several plateaus are quite scenic and contain high mountain lakes.

The ABW includes about 640 lakes, most in the Beartooth mountains. Nine major drainages provide substantial headwater flow to the Yellowstone River system. Many high plateaus are located above timberline, usually around 10,000 feet elevation, and bear a strong resemblance to arctic tundras. These relatively flat plateaus characteristically break off sharply to intervening canyons and steep finger ridges. Plateaus below timber line are characteristically open and grassy.

Buttercups, Shooting Stars and other wildflowers follow the retreating snowbanks each spring. The growing season in the Beartooths is particularly short, usually lasting a scant 6 to 12 weeks (June to August). In the Absaroka's spring bloom arrives a little earlier and lasts a little longer.

More than 700 miles of hiking trails provide access to the ABW. Both ranges offer opportunities to wander off-trail for a primitive Wilderness experience. Wilderness pack trips have a long history in the area, often supported by outfitters.

Lee Metcalf Wilderness

Monument Peak Unit of the Lee Metcalf Wilderness

The Lee Metcalf Wilderness was designated on 10/31/1983 (PL 98-140). Alpine glaciation has produced steep, rugged, knife-edge ridges and numerous cirques containing lakes surrounded by alpine meadows. Elevation of several peaks exceeds 11,000 feet. The wilderness consists of four separate units in the Madison range; the Spanish Peaks (76,406 acres), Taylor-Hilgard (141,000 acres), Monument Mountain (32,891 acres), and Bear Trap Canyon (6,347) in the Beaverhead and Gallatin National Forests and the Dillion Field Office of the BLM. The Spanish Peaks unit forms the north part of the LMW, with Big Sky Ski resort in the center, and Taylor Hilgard and Monument Mountain units in the south. The Spanish Peaks unit has numerous peaks and lakes and a well developed trail system. The Taylor-Hilgard unit also has numerous peaks but has a much less developed trail system.

Topography is highly variable. Glaciated relief is the dominant landtype with rocky peaks and ridges and cirque basins separated by U-shaped valleys. Elevations range from 11,316 on Hilgard Peak to 4500' at the lower end of Beartrap Canyon. Major drainages include Bacon Rind and Snowslide Creeks flowing east into YNP; Cedar, Bear, Indian, Wolf, Moose, Squaw, Papoose, and Hilgard Creeks flowing south and west through the Beaverhead NF to the Madison River, and Hell Roaring, Cascade, the West Gallatin River, Taylor Fork, and Tepee Creeks flowing into the Gallatin River.

Vegetation consists of sagebrush, grasslands, and scattered trees at lower elevations. Mid elevations are dominated by lodgepole pine and Douglas fir. Mountain meadows and open parkland are common in the higher elevations. The crest of the LMW features exposed bedrock, sparse tree cover, and brush and mountain meadows. Forested terrain is more common in the northern two-thirds of the LMW.

Grizzly Bears are not commonly seen in the Spanish Peaks, but the Taylor-Hilgard and Monument Peaks units of the Lee Metcalf wilderness area are within occupied grizzly bear habitat with substantial grizzly bear populations.

3) Policy and Direction

The Wilderness Act of 1964 contains language directing the management of wilderness to "…secure for the American people…and future generations the benefits of an enduring resource of wilderness …unimpaired for future use and enjoyment" (Wilderness Act, PL 88-577, Sec. 2a) It further states that Congress intended to manage these wildernesses so that "…the earth and it's community of life are untrammeled by man…" and a wilderness must"…retain it's primeval character and influence…" and it"…appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable…" (Sec 2b). The direction provided in this act made it clear that Congress intended that the natural conditions in wilderness be preserved and that it be influenced primarily by the forces of nature rather than by human activity. The basic framework for controlling air pollutants in the United States is mandated by the Clean Air Act (CAA) of 1963, and amended in 1970, 1977, and 1990. The CAA was designed to "protect and enhance" air quality. Section 160 of the CAA requires measures "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreation, scenic, or historic value." Stringent requirements are therefore established for areas designated as "Class I" areas. Class I areas include Forest Service and Fish and Wildlife Service wilderness areas over 5,000 acres that were in existence before August 1977 and National Parks in excess of 6,000 acres as of August 5, 1977. Designation as a Class I area allows only very small increments of new pollution above already existing air pollution levels. Class II areas include all other areas of the country, that are not Class I. To date, there are no class III areas. The Absaroka Beartooth Wilderness and the Lee Metcalf Wilderness areas are Class II areas since they were established after 8/5/77 (ABW in 1978 and LMW in 1983).

The purpose of the CAA is to protect and enhance air quality while ensuring the protection of public health and welfare. The act established National Ambient Air Quality Standards (NAAQS), which must be met by state and federal agencies, and private industry. The EPA has established NAAQS for specific pollutants emitted in significant quantities that may be a danger to public health and welfare. These pollutants are called criteria pollutants and include carbon monoxide, nitrogen oxide, ozone, sulfur dioxide, lead, and particulate matter (PM_{10} and $PM_{2.5}$). States are given primary responsibility for air quality management. Section 110 of the Clean Air Act requires States to develop State Implementation Plans (SIP) that identify how NAAQS compliance will be achieved. The NAAQS are designed to protect human health and public welfare. The CAA defines public welfare effects to include, but not be limited to, "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being" (CAA Title 1, Part A, S. 109 http://www.epa.gov/air/criteria.html). If a community or area does not meet or "attain" the standards, it becomes a non-attainment area and must demonstrate to the public and EPA how it will meet standards in the future. This demonstration is done through the SIP.

Criteria pollutants such as sulfur dioxide and nitrogen dioxide are of concern because of their potential to cause adverse effects on plant life, water quality, aquatic species, and visibility. However, sources of these pollutants are generally associated with urbanization and industrialization rather than with natural resource management activities or wildfire. Wildfire and

natural resource management activities such as timber harvest, road construction, site preparation, mining, and fire use can generate ozone, carbon monoxide, and particulate matter. While ozone is a by product of fire, potential ozone exposures are infrequent (Sandberg and Dost 1990). The EPA is recommending a secondary ozone standard which will protect vegetation and animals http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_sp.html. Carbon monoxide is rapidly diluted at short distances from a burning area, as fires are generally spatially and temporally dispersed, and pose little or no risk to public health (Sandberg and Dost 1990).

The pollutant of most concern to public health and visibility in the ABW and LMW is particulate matter. Even though particulate matter has no serious effects on ecosystems (fire and smoke are natural processes) it does affect human health and visibility. Because of its smaller size, $PM_{2.5}$ poses greater respiratory health system risks than $PM_{10.}$

The $PM_{2.5}$ standard requires concentrations of $PM_{2.5}$ not to exceed a 24-hr average of 35 ug/m^3 (micrograms per cubic meter). This standard was changed from previous 65 ug/m3 by the EPA on 12/17/06 http://www.epa.gov/particles/fs20061006.html. Average annual arithmetic $PM_{2.5}$ concentrations are not to exceed 15 ug/m^3. Air quality State Implementation plan (SIP) for particulates is promulgated through the Montana Clean Air Act and implementing regulations. The regulations provide specific guidance on maintenance of air quality, including restrictions on open burning (ARM 16.8.1300). The act created the Montana Air Quality Bureau (now the DEQ) and the regulatory authority to implement and enforce the codified regulations.

4) Pollution Sources and Air Quality Conditions

Air quality within the ABW and LMW areas is excellent with very limited upwind local emission sources and robust wind dispersion with no consistent local visible sources of impairment. Existing sources of emissions in the wilderness areas include dust from trails and campsites and smoke emissions from wildfires, wildland fire use, and prescribed burns. Adjacent area emissions include occasional construction equipment, vehicles, road dust, residential wood burning, wood fires, and smoke from logging slash disposal, prescribed burns, and wildfires. The Spanish Peaks unit of the LMW receives vehicle, residential, construction, and ski area emissions from the Big Sky area. Down valley airflow in the ABW and LMW drainages is frequently robust during nighttime and early morning hours. The entire ABW and LMW is considered to be in attainment by the Montana DEQ.

The nearest non-attainment area for the ABW is Laurel (50 miles and 69 miles east of the closest ABW boundary) The Billings/Laurel area has 7 major $S0_2$ and particulate sources including the Exxon oil refinery, Conoco oil refinery, Montana Power coal fired electric power generating facility, Western Sugar beet factory, Yellowstone Energy Limited Partnership coke fired cogeneration power plant, Montana Sulphur and Chemical sulfur recovery facility, and the Cenex oil refinery. The Billings and Laurel sources are currently permitted for 1,928 tons of PM_{10}/year and 16,481 tons of $S0_2$ per year. Currently Laurel is in non-attainment for $S0_{2.}$ The predominant west to southwest winds carry most of the Billings/Laurel emissions to the east and away from the ABW except for occasional upslope east winds which area usually unstable with robust wind velocities. The major source of emissions affecting the ABW in the Yellowstone valley are the cities of Big Timber and Livingston, and Bozeman in the Gallatin valley with vehicle exhaust, wood burning smoke, and road dust. These communities are in compliance with National

Ambient Air Quality Standards (NAAQS). Big Timber, Livingston, and Bozeman emissions do not visibly impact the ABW. These emissions are dispersed by predominant and S and SW wind direction with robust Yellowstone valley wind gradients which usually carry emissions north of the ABW. Other types of emissions in the Yellowstone valley which could affect the ABW include vehicle and agriculture equipment exhaust, road dust, wood smoke from residential, smoke from pile burning, broadcast burning, and wildfires.

Butte for PM_{10} is the nearest non-attainment area upwind of the LMW (60 miles NW of the closest LMW boundary). The major source of emissions in the Gallatin valley, north of the LWM is the city of Bozeman with vehicle exhaust, wood burning smoke, and road dust although Bozeman is in compliance with National Ambient Air Quality Standards (NAAQS). Smaller amounts of emissions occur from Belgrade and Three Forks/Willow Creek and from vehicles on Interstate 90 and Highways 191, 345, and 287. The main permitted industrial sources in the Gallatin valley http://www.epa.gov/air/data/reports.html include the Jell Group at Belgrade (paving mixtures and blocks), Holcim Inc. at Three Forks (cement), Luzenac America (Three Forks), and the Montana State University central heating plant. These 4 sources combine for a permitted 450 tons of PM_{10}/year and 193 tons $S0_2$ year which are small amounts of industrial emissions compared to the Helena or Billings/Laurel areas. Bozeman emissions visibly do not impact the LMW since these emissions are dispersed by predominant W and SW wind direction. Evening down air drainage from the north end of the Gallatin valley frequently carries Bozeman emissions north and west. This process is particularly noticeable in the winter when inversions frequently constrain mixing heights over Bozeman and the emissions drift down the Gallatin valley toward Belgrade. Other types of emissions in the Gallatin valley include vehicle and agriculture equipment exhaust, road dust, wood smoke from residential, smoke from pile burning, broadcast burning, and wildfires.

The nearest Class I area to the LMW is Yellowstone National Park which abuts the Monument Mountain Unit of the LMW,

No specific information is available concerning existing air quality within the ABW or LMW. The nearest particulate data to the ABW (7 miles NE) is from the East Boulder Mine EIS (MSDL, USFS, DHES; 1992, p 3-63) which documented PM_{10} at the East Boulder mine site at an annual geometric mean of 9 ug/m^3 and a maximum 24hr PM_{10} concentration of 35 ug/m^3. The emissions from the East Bounder mine sources are predominantly dispersed to the northeast with no visible effects within the ABW. The DEQ has estimated that for southwest Montana, including the Absaroka, Beartooth, and Madison, ranges, a PM_{10} background of 5 ug/m3 (annual average) is appropriate.

Regional wildfire smoke has accumulated within the area during periods of extensive wildfire activity in 1988, 1994, 2000, 2003, and 2006. The prime source of wildfire emissions is from central and southern Idaho, and SW Montana. Smoke can also impact the ABQ and LMW area from wildfires in Yellowstone National Park as occurred in 1988.

Generally the ABW and LMW areas do not develop temperature inversions, which trap smoke and reduce smoke dispersal. Dispersion of emissions within the ABW and LMW is very high due to the mountainous terrain and high wind activity. The Wind Energy Resource Atlas of the U.S. (Elliott et.al., 1986) shows the ABW and LMW as areas of high wind energy. The Main Boulder Canyon, Gallatin Canyon, and the West Fork Gallatin (Big Sky) have some potential for cumulative concentrations of smoke and residential and transportation emissions. Visible inversion conditions occasionally occur in the Big Sky area which has been designated as the Big Sky Impact Zone by the Montana DEQ
http://www.deq.state.mt.us/AirQuality/Planning/MONTANA_SMOKE_MGNT_impact_zone.htm

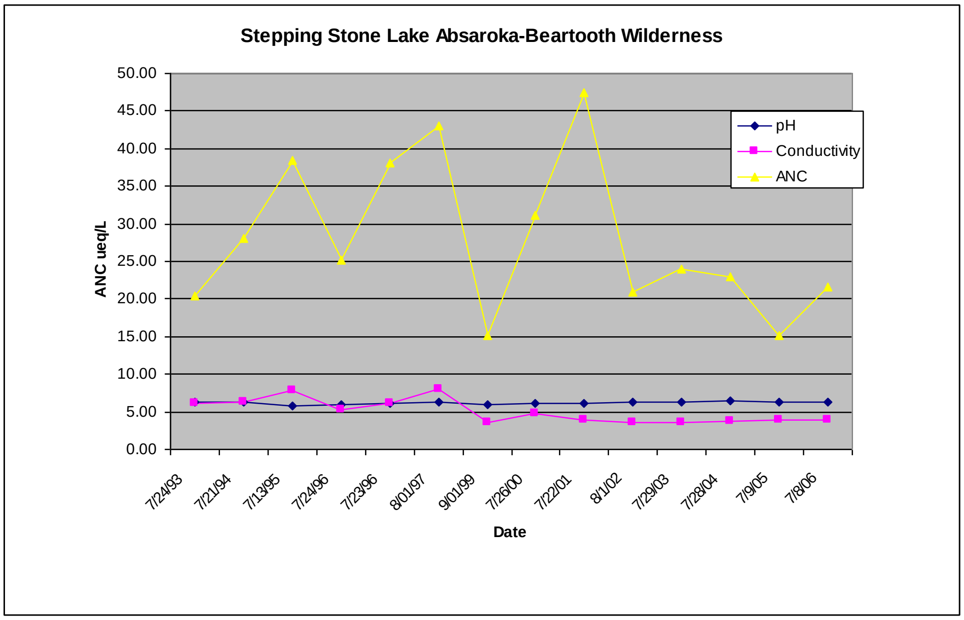
Up valley winds during daytime and down valley wind (cold air drainage) at night can dominate valley winds more than overall prevailing wind direction on ridgetops.

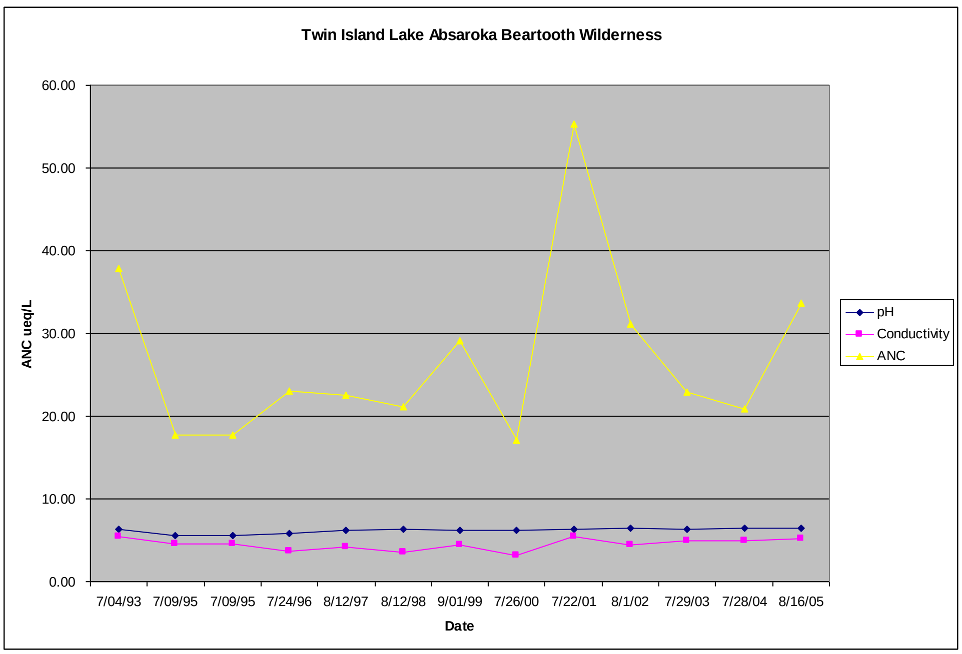
No specific information is available concerning existing air quality within the LMW area. The Environmental Protection Agency (EPA) Air Quality System (AQS) database http://www.epa.gov/air/data/reports.html includes PM_{10} data for Bozeman. Average PM_{10} values in Bozeman were 19 ug/m3 in 1998, 21 ug/m3 in 1999, 20 ug/m3 in 2000, 18 ug/m3 in 2001, 19 ug/m3 in 2002, 17 ug/m3 in 2003, 15 ug/m3 in 2004, and 16 ug/m3 in 2005. Maximum measured PM_{10} at Bozeman was 51-89 ug/m3, with no exceedances of the PM_{10} 150 ug/m3 hourly standard. The highest PM_{10} values for Bozeman occurred in the widespread wildfire years of 2000 and 2001.

Lake Chemistry

This chemical record can indicate changes in a lake's composition, which in sensitive lakes is very diagnostic of atmospheric chemistry. Imbalance of lake chemistry can affect microorganisms, and invertebrates, ultimately affecting the health and productivity of fish which in turn has an effect on naturalness. The Lake chemistry in the ABW was monitored by the EPA (1985) Western Lake Survey at 13 lakes, and the LWM at 14 lakes (Landers, et.al, 1987). The USFS sampled 35 lakes (USFS Region 1 Phase 2 – synoptic monitoring) in the ABW in 1993, 19 in 1994, and 14 in 1995 as reported in Story (1993, 1994a, 1995). Two lakes (Twin Island and Stepping Stone in the GNF) were selected for long term annual monitoring as part of the 6 lake USFS Region 1 Phase 3 long term monitoring as reported in Story (1999, 2002) and Eilers (2003). The WLS lake data and some of the USFS lake data is mapped and available at http://www.fs.fed.us/waterdata/ Lake reports are available at the USFS R1 air quality web site at http://www.fs.fed.us/r1/gallatin/resources/air/index.shtml

A key indicator of buffering capacity and therefore pH and chemical/biological stability in a lake is acid neutralizing capacity (ANC), which is similar to alkalinity and is the sum of the base cations minus acid anions. Lakes are generally considered sensitive to atmospheric induced acid deposition change if ANC is less than 50 ueq/L and highly sensitive if ANC is less than 25 ueq/L. In 1993 the 35 ABW lakes sampled had an average ANC of 71.2 ueq/L with 12 lakes less than 50 ueq/L and 4 lakes less than 25 ueq/L. In 1994 the 19 ABW lakes sampled had an average ANC of 59.7 ueq/L with 9 lakes less than 50 ueq/L and 2 lakes less than 25 ueq/L. In 1995 the 14 ABW lakes sampled had an average ANC of 46.2 ueq/L with 7 lakes less than 50 ueq/L and 3 lakes less than 25 ueq/L. The lakes with least ANC occurred at highest elevations (10,000' and higher), alpine, gneiss/granite watersheds. The 2 lakes selected for long term (Phase 3 monitoring) were Twin Island (1993 ANC of 37.9 ueq/L) and Stepping Stone (20.4 ueq/L).





During 1993 to 2005 Stepping Stone and Twin Island Lake had generally stable pH and conductivity but considerable variation in ANC.   Eilers (2003) could not statistically detect any trends in ANC at either lake although since Eiler's analysis Stepping Stone Lake ANC has dropped and Twin Island ANC has increased.

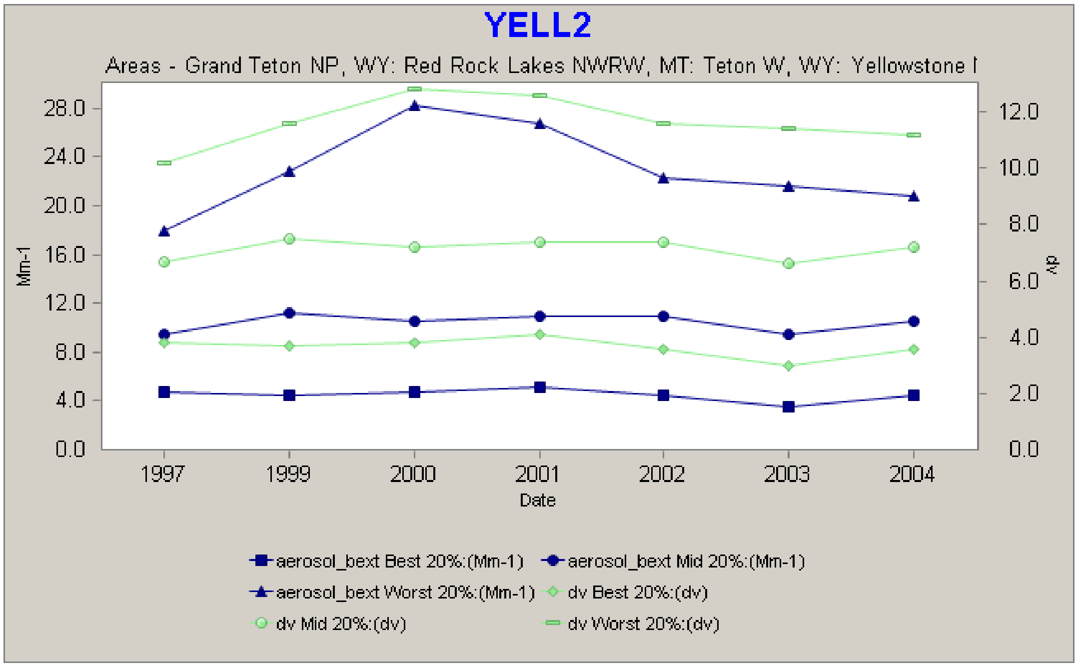
A primary purpose of the Phase 3 lake monitoring program is to utilize the sensitive nature of the Phase 3 lakes in defining and protecting these sensitive AQRV's (air quality related values). The MAGIC model (Model of Acidification of Groundwater in Catchments) was used to calibrate the 2 ABW Phase 3 lakes (Twin Island and Stepping Stone) in 1999. The MAGIC model is a state of the art acid deposition watershed/soils/lake chemistry model for non-research watersheds. The model uses a lumped parameter code of intermediate complexity which

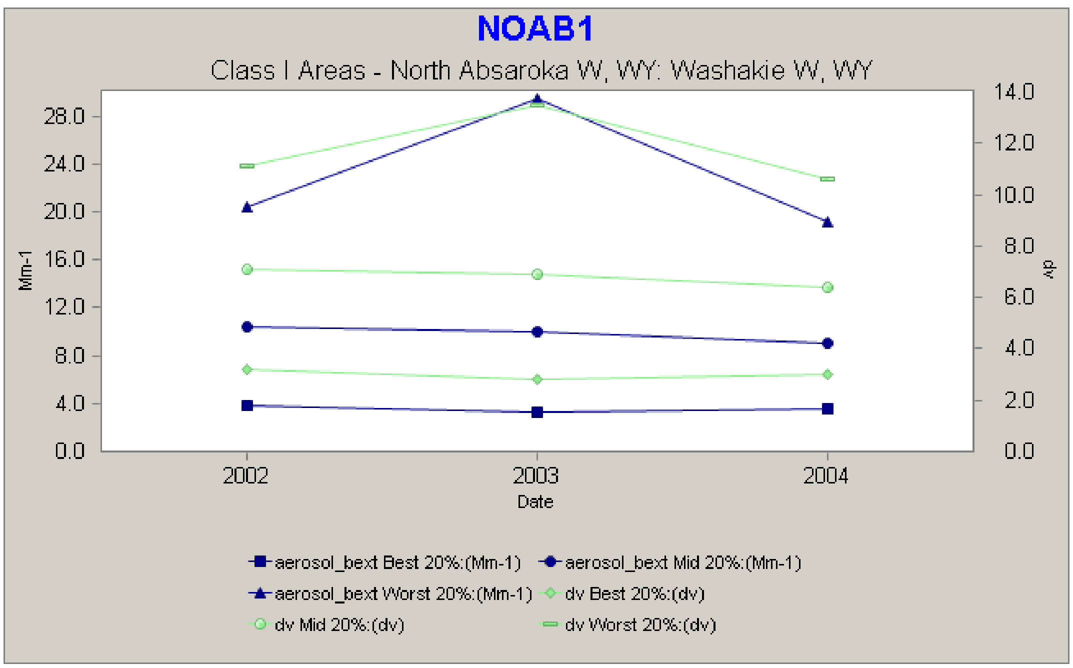
simulates several soil and water chemistry constituents in accounting for atmospheric deposition and watershed interaction of bedrock, soils, and lake dynamics. MAGIC simulates soil solution and surface water chemistry to predict monthly and annual average concentrations of the major ions in lake water. The model is useful in PSD analysis of lake AQRV's to evaluate if potential upwind emission may pose adverse changes to lake chemistry characteristics and has been used for several PSD applications and gas leasing EIS's for the ABW. The ABW lakes Stepping Stone and Twin Island are less sensitive than the other R1 Phase 3 lakes (Cabinets Mountains and Selway Bitterroot WA's) due primarily to slightly deeper soils. The 2 ABW lakes, although with relatively chemically stable ANC statistical trends, are sensitive and important air pollution trend indicators for the ABW and the northern Greater Yellowstone Area.

Eleven Lee Metcalf Wilderness Lakes were sampled during July and August of 1994 (Story, 1994b). None of the LMW lakes are considered to be sensitive to acid deposition. The LMW lakes sampled had an average ANC of 232 ueq/L with no lakes less than 50 ueq/L. The ANC ranged from 67.8 ueq/L in Jerome Rock Lake #1 to 357.8 ueq/L in Thompson Lake. The 3 Jerome Rock lakes had lower acid deposition sensitivity than any of the other LMW lakes.

Visibility

Visibility in both the ABW and MMW is excellent due to absence of large stationary sources, generally dry air, and robust wind dispersion. No visibility monitoring stations are located in or immediately adjacent to either the ABW or LMW. However, the Interagency Monitoring of Protected Visual Environments (IMPROVE) program (http://vista.cira.colostate.edu/improve/)has 2 IMPROVE sites near the ABW including Yellowstone National Park near the Lake Ranger Station (33 miles from the ABW) and at Dead Indian Pass for the North Absaroka Wilderness (33 miles from the ABW). The Yellowstone NP IMPROVE site (YELL2) has been operated since 1997 and the North Absaroka Site (NOAB1) since 2000. Trend data is available at http://vista.cira.colostate.edu/dev/web/AnnualSummaryDev/trends.aspx which shows visibility trends since the stations were installed. The graphs below show trends in light extinction and deciviews which are indicies of visibility. Light extinction, measured in units of inverse megameters(Mm^{-1}) is a measure of the amount of image-forming information lost in a sight path due to aerosols in the atmosphere. The deciview unit is a haze index which is a measure of visibility derived from calculated light extinction measurements so that uniform changes in the haze index correspond to uniform incremental changes in visual perception across the entire range of conditions from pristine to highly impaired. The haze index [in units of deciviews (dv)] is calculated directly from the total light extinction [bext expressed in inverse megameters (Mm-1)] as follows: $HI = 10 \ln (b_{ext}/10)$. The trends for Yellowstone Park show generally stable visibility with the lowest visibility (dv) occurring during 2000 and 2001 which were robust wildfire years in the northern GYA. The North Absaroka IMPROVE site had the highest deciviews during 2003 which was also an active wildfire year in the northern GYA.

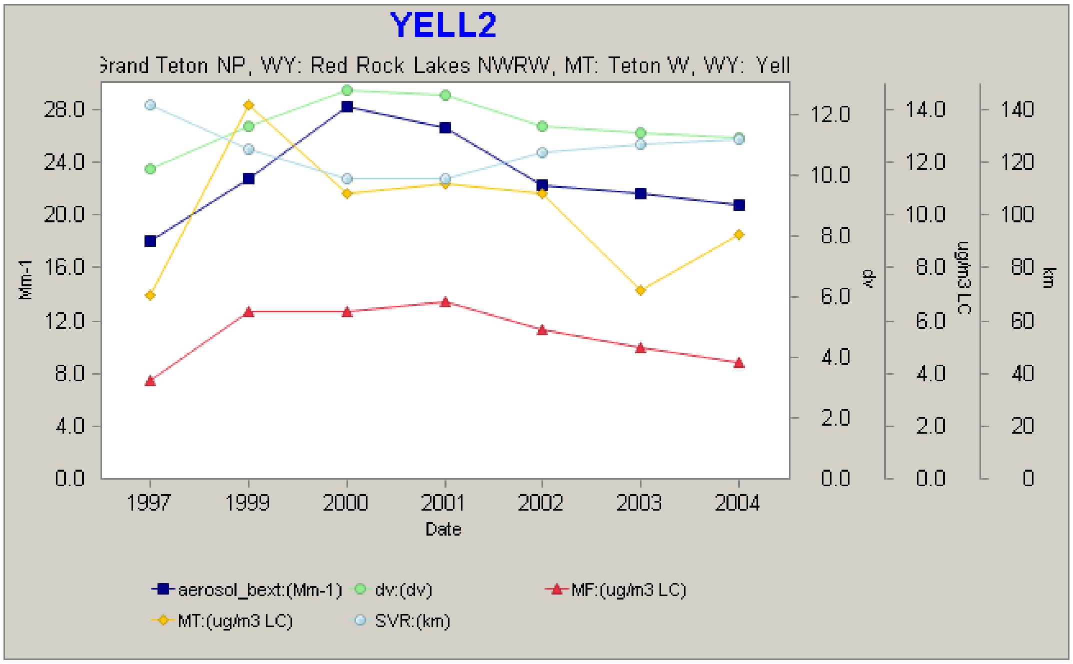


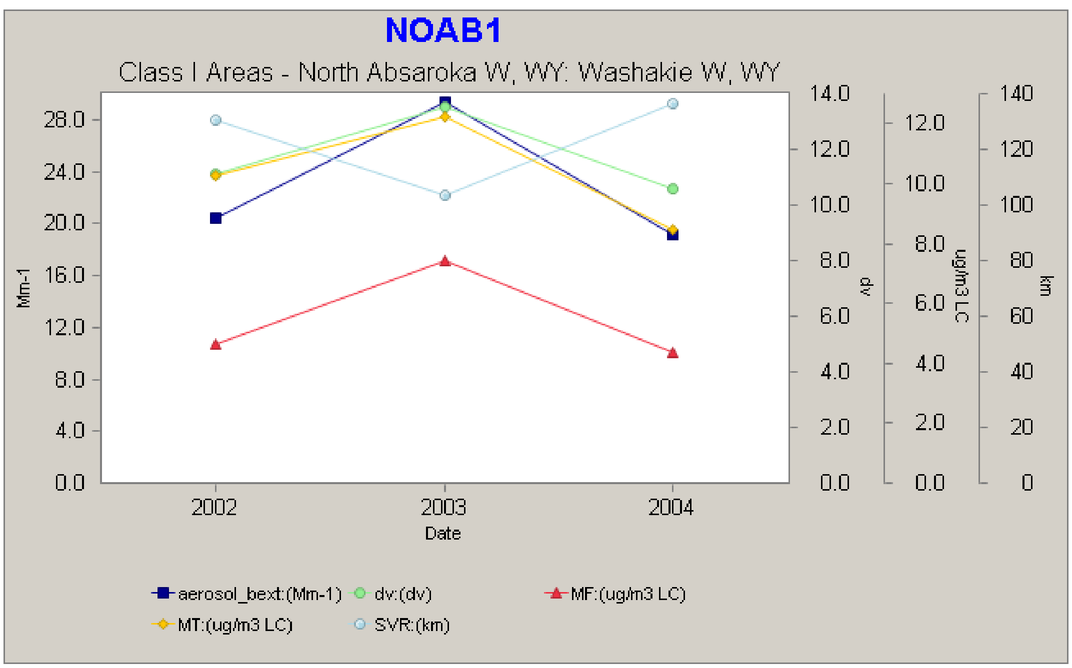


The IMPROVE data was also converted for SVR (standard visual range in kilometers) and deciviews which shows the inverse correlation between SVR and deciviews. For YNP and North Absaroka Wilderness the visibility is closely coorelated to wildfire activity.

Since the YELL2 and NOAB1 sites are proximate to the ABW with only very minor emission sources between (mainly highways and Cooke City, Montana) these sites are reasonable approximations of visibility conditions in the ABW. For regulatory purposes, YELL2 is considered representative of Red Rock Lakes which is very near LMW.

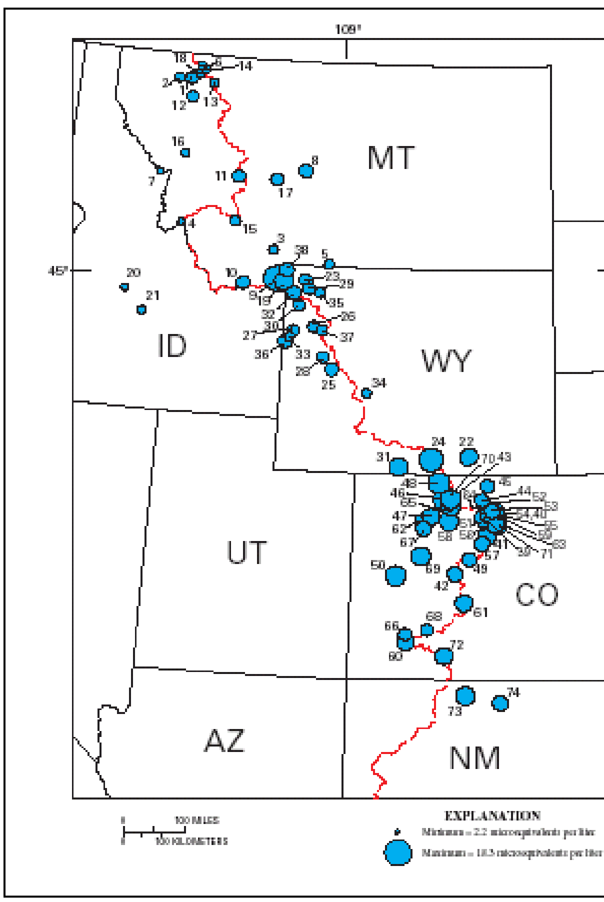
To a lesser degree the YELL2 site provides “umbrella” visibility coverage to the LMW for general visibility conditions.

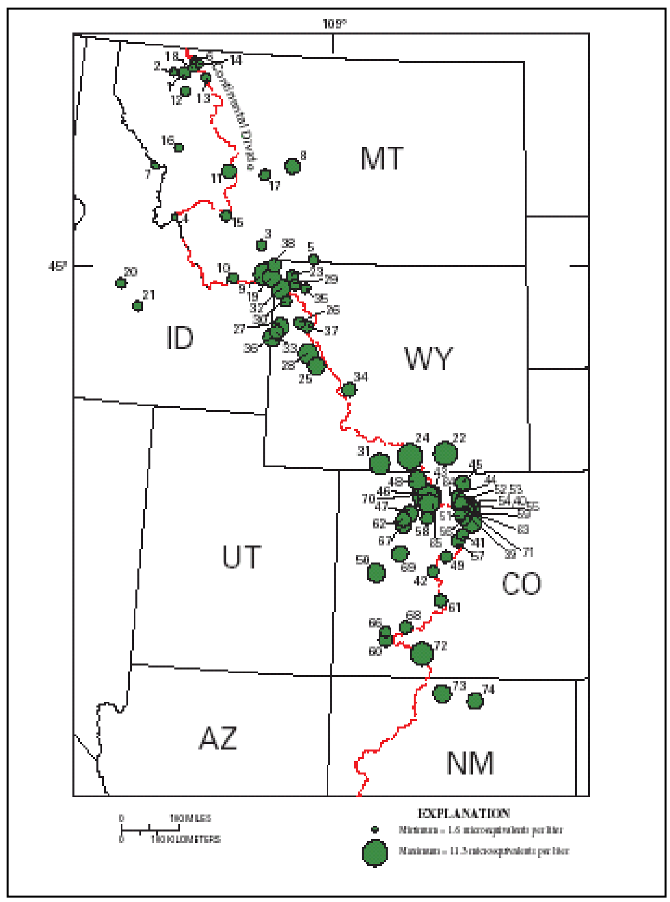




Snow Chemistry

The United States Geological Survey (USGS) Water Resource Division in Colorado, in cooperation with the USFS, NPS, and multiple other agencies and interest groups has been monitoring 52 seasonal (late winter), depth integrated, bulk snowpack sites along the Continental Divide from New Mexico through Montana since 1993, (Ingersoll et. al., 2002a) http://pubs.usgs.gov/of/2001/ofr01-466/ . Seven of these sites are near the ABW or LMW including 4 sites in Yellowstone NP (West Yellowstone, Canyon, Lewis Lake, and Sylvan Lake) and 3 additional sites on the Gallatin NF (Big Sky, Daisy Pass, and Lionshead). Bulk late winter snowpack samples provide a very useful diagnosis of chemical deposition (H^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, HN_4^+, SO_4+, NO_3-, and Cl-) from all transport sources (short and long range) through the late fall and winter period. The samples are collected in a depth integrated fashion prior to spring snowmelt rinsing of the snowpack which quickly flushes the soluble chemical constituents from the snowpacks (Ingersoll et. al., (2001, 2002, 2003, 2004, and 2005). The snowpack monitoring has documented generally decreasing levels of snowpack contaminants from south (New Mexico and Colorado) north through Montana as shown in the graphs below in Ingersoll et. al, 2003, for nitrate and sulfate http://pubs.usgs.gov/of/2005/1332/. The diameter of circle is representative of average nitrate and sulfate concentrations.. Montana and Northern Wyoming snowpacks have generally low (dilute) amounts of contaminants except samples collected near areas of heavy snowmobile use in YNP (Ingersoll, 1998) and at the Lionshead site near West Yellowstone (11 miles south of the LMW) where nitrate, sulfate, and ammonium have been consistently elevated, presumably from dust contamination of the snowpack from upwind agricultural areas in Idaho.





5) Wilderness Air Quality Values

Absaroka Beartooth Wilderness

The Absaroka Beartooth Wilderness contains a vast and diverse scenic resource highlighted by a number of alpine peaks in both the Absaroka Range and Beartooth Range. Numerous peaks in the Absaroka Range hover in the 10,000' range, with only one (Mt. Cowan) exceeding 11,000'. The Beartooth Mountains, however, include over 35 peaks above 11,000 feet, half of which are over 12,000'. Granite Peak at 12,799 is the highest peak in the state of Montana. Several of the rugged peaks are surrounded by glaciers and perennial snowfields with some of the most spectacular alpine scenery in Montana. The Absaroka Beatooth Wilderness also contains a number of very deep canyons and alpine plateaus. The plateaus are treeless areas of about 10,000 feet in elevation strewn with rock remnants. The plateaus break off sharply to intervening canyons. Elevations range from the 12,799 foot Granite Peak to 5,000 feet along the lower Stillwater River. Spectacular views exist in all directions from the higher parts of the Beartooth Plateaus and peaks. The views include the spectacular scenery within the Wilderness area, the surrounding northern plains lying generally below the 5000 foot level, and many distant mountain ranges outside the Wilderness Area including the Crazy, Snowy, Pryor, Bighorns, Little Belts, Castles, and Bridgers which range from 25 to 100 and more miles distant. Views to the southwest are similarly spectacular with seemingly unending mountain peaks in and around Yellowstone Park, primarily of the Absaroka Range (North Absaroka Wilderness and YNP) and the Gallatin Range. From the highest peaks on very clear days the Grand Tetons are visible (about 120 miles to the southwest). The Absaroka Beartooth Wilderness contains 641 lakes, most of which are on the Beartooth Plateau. Many of these lakes are glacially scoured in Precambrian granite and metamorphic parent material, and have low levels of alkalinity buffering to pH change. The Absaroka Beartooth lakes generally have low levels of alkalinity , some as low as 1-2 mg/l. The lakes contain a rich and diverse aquatic ecosystem and fishery resource. The Absaroka Beartooth Wilderness contains the most extensive mountain lake fishery in Montana. Game fish in the area include brook trout, brown trout, (generic) cutthroat trout, Yellowstone cutthroat trout, golden trout, and Montana Artic grayling. Slough Creek, which flows into Yellowstone National Park, contains a Yellowstone cutthroat trout fishery of national significance.

<u>Alpine Ecosystems</u>

The Absaroka Beartooth Wilderness contains a number of unique, high elevation tundra plateaus such as Hellroaring, Beartooth, Froze to Death, and Lake plateau. These tundra plateaus are extremely fragile with thin soils, miniature alpine forbs and shrubs (some over 200 years old). This Arctic tundra habitat contains one of the largest contiguous land areas above 10,000 feet in the lower 48 states. The Beartooth tundra plateau contains substantial acres of permafrost (Pergilic) soils and associated tundra ecosystem plant vegetation which are adapted to, and dependent on the cold, pristine environment. Over 200 plant species are represented in the Beartooth tundra ecosystems, with Geum turf and Deschampsia meadow communities most prevelant (Johnson and Billings, 1962). Geum turf communities are dominated by cushion plants (phlow, polygonum, luzula, etc.) and sedges (Deschampsia, Carex, Poa, etc.) with alpine willows, sage and several other forbs present. Several sensitive plant species occur in the area, including (but not limited to) Agoseris sp., Erigeron eatonii, Draba porsildii, Thlaspi parviflorum, Pagaver kluanensis, Ranunculus jovis, Selaginalla watsonii, and Kobresia macrocarpa (Montana Heritage, 1990). Several of these species are recognized as sensitive by the Forest, Service; all are considered imperiled by the Montana Natural Heritage Program. The

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Wildlife

An abundance and wide diversity of wildlife exists in the Absaroka Beartooth Wilderness. The wilderness contains huge blocks of unfragmented land which provide seasonal ranges and relatively undisturbed migration routes for large herds of ungulates. Herds within the wilderness are supplemented with an influx of animals from protected populations in nearby Yellowstone National Park. Included in these migratory herds are elk, mule deer, bighorn sheep, and bison. Not all ungulates within the wilderness are migratory; significant resident populations also exist. Important populations of moose exist in the upper reaches of some drainages. Mountain goats, though not indigenous, occupy the rugged portions of the wilderness where they seem well suited to the extensive alpine environment and precipitous topography. A portion of the Absaroka Beartooth Wilderness is designated as recovery area for the threatened grizzly bear. The wilderness setting provides a large expanse of undeveloped land, an exceptional prey base, and habitat which meets the security and foraging needs of the great bear. The same elements that make this good grizzly habitat also enable the black bear to thrive. The vast number of ungulates support a healthy population of mountain lions, and confirmed sightings of wolverines have been made. Coyotes, wolves, and other smaller predators also thrive in the wilderness. The endangered bald eagle, the golden eagle and many other birds of prey can be found here as well. The wilderness provides high quality wetland habitat which serves as home to numerous species of ducks, geese, swans and other waterfowl. Songbirds abound in a multitude of species throughout the wilderness.

Lee Metcalf Wilderness

Visibility/Scenery

The Lee Metcalf Wilderness is located in 3 units in the Madison Range (Spanish Peaks Unit, Taylor Hilgard Unit, and Monument Mountain Unit). The scenery features snowclad peaks, glacial lakes, waterfalls, waterfalls, mountain meadows, wildflowers, and a visual variety of rock, snow, and ice. Five peaks within the LMW exceed 11,000 feet in elevation. Several peaks within the LMW are surrounded with perennial snowfields with very spectacular alpine scenery. Expansive views exist within and in all directions from the higher peaks of the Lee Metcalf Wilderness including peaks within the Madison Range, plains adjacent to the Wilderness, and

several mountain ranges including the Gallatin, Absaroka, Beartooth, Bridger, Big Belt, Elkhorn, Centennial, Gravelly, and Tobacco Root Mountains

Lakes

The Lee Metcalf Wilderness contains 111 lakes, most of which are in the Spanish Peaks and Taylor Hilgard Units. Many of these lakes are glacially scoured in Precambrian granite and metamorphic parent material, and have low levels of alkalinity buffering to pH change. The Lee Metcalf Wilderness lakes generally have low levels of alkalinity, some as low as 2-5 mg/l of alkalinity. The lakes contain a rich and diverse aquatic ecosystem and fishery resource. Predominant fish species include brook trout, Yellowstone and Westslope Cutthroat trout, rainbow trout, Artic grayling, and golder trout .

Wildlife

Wildlife is abundant throughout the Lee Metcalf Wilderness Area. Many species, including big game, small game, nongame, waterfowl and furbearers inhabit the area. The wilderness provides large blocks of unfragmented land which are capable of supporting migratory as well as resident wildlife populations. Elk, moose and deer can be found throughout the area. Bighorn sheep and mountain goats summer in the higher elevations of the Taylor, Hilgard and Spanish Peaks. The Taylor Hilgard Unit and the Monument Mountain Unit are included within the recovery area for the threatened grizzly bear. Although not in the official recovery area, the Spanish Peaks Unit also receives some transitory use by the grizzly bear. The black bear thrives in all three units. Although they are not as likely to be seen, mountain lions, bobcats, and wolves are also present. Smaller mammals which inhabit the area include coyotes, wolverines, foxes, rabbits, beaver, marmots, squirrels, chipmunks, picas and field mice. Birds of prey, waterfowl and songbirds abound.

6) Monitoring Plan

This ABW and LMW WAQV plan is designed to specify appropriate monitoring to protect the Class 2 WAQVs in the Absaroka Beartooth and Lee Metcalf Wilderness areas and to meet the Wilderness Stewardship Challenge to achieve the objectives of the Air Element #3 http://www.wilderness.net/index.cfm?fuse=toolboxes&sec=air

The Wilderness Stewardship Challenge steps include selecting air quality values with an interdisciplinary team, rank air quality values, select receptors, and identify indicators to measure at the sensitive receptors. For the ABW and LMW, the process included a review of existing air quality information in and adjacent to the ABW and LMW with a determination that existing monitoring in the USFS lake chemistry, IMPROVE, NADP, and USGS snow chemistry monitoring networks is sufficient to characterize and monitor ABW and LMW air quality for the key sensitive receptor (scenic vistas) and sensitive indicator (visibility) except for some additional lake monitoring in the LMW. This ABW and LMW monitoring plan proposes not to do additional NADP, visibility, or particulate monitoring at this time since these air quality parameters are being adequately monitored in existing networks. Air quality monitoring in the ABW and LMW will continue to be done with the existing USFS lake chemistry, IMPROVE, NADP, USGS snow chemistry networks and tracked and tabulated by USFS R1 Air Resource Management staff. This ABW and LMW WAQV plan will need to be re-evaluated within a 5-10 year interval to insure monitoring sufficiency, particularly if upwind emission sources increase.

Visibility: The Absaroka Beartooth Wilderness and Lee Metcalf WAQV monitoring plan is designed to provide additional information for the Class 2 WAQV's to supplement the existing Class 1 monitoring. Visibility in the ABW is being reasonably characterized and monitored by the "umbrella" of the IMPROVE visibility monitoring sites at Yellowstone National Park (YELL2) and the North Absaroka Wilderness (NOAB1) Visibility at those 2 monitoring sites has documented excellent visibility with periodic reduction during periods of active wildfire. No large upwind industrial sources of air pollution occur between YELL2 and NOAB1 and the Absaroka Beartooth Wilderness. Characterization of visibility in the Lee Metcalf Wilderness is less efficiently related to the YELL2 IMPROVE site but can be considered to be reasonably correlated since no major stationary sources visibility impact the remaining northern parts of the LMW. No additional visibility monitoring stations are recommended or planned for the ABW or LMW.

Lake Chemistry: Two lakes in the Absaroka Beartooth Wilderness (Twin Island and Stepping Stone lakes) have been monitored for a wide variety of cations and anions 1-2 times per year since 1993 and are part of the USFS R1 ongoing air quality monitoring program. These lakes will be continued to be monitored on an annual basis in July. In 2007, the 3 most sensitive lakes in the Lee Metcalf Wilderness (Jerome Rock Lakes) will be monitored in July. The LMW lakes will be monitored on a periodic basis approximately every 5-10 years. Mark Story will provide monitoring equipment, forms, and protocols. Techniques for the lake sampling include collection of primary and duplicate samples in the deepest part of each lake (raft access) in 250 ml sample bottles using sterile techniques. Surface Water Chemistry Monitoring Record Form and Chain of Custody forms will be completed and samples kept cool and immediately shipped to the USFS Fort Collins Science Center Lab. Laboratory analysis includes Fort Collins Science Center Lab Procedures: For pH & alkalinty--Acid Rain Analysis System (ARAS) gran technique; specific conductance--YSI meter; chloride, sulfate, nitrate, ammonia, phosphate, calcium, potassium, sodium, magnesium --liquid ion chromatography; floride--ion specific electrode; aluminum and silica--Lachat flow injection system. Selected magnesium and calcium chromatography values with atomic absorption (Thermo Jarrell Ash 22E). All analyses used QA/QC guidelines and EPA reference standards established in the Handbook of Methods for Acid Deposition Studies (EPA 600/4-87/026 and Standard Methods (APHA, 1989). The data will be reviewed for conformance with quality assurance standards prior to use. All of the lake data is available on the USFS NRIS-Air database and on spreadsheets by USFS R1 Air Quality staff

Snow Chemistry

Snow chemistry will continue to be cooperatively monitored in late February and early March with the USGS Water Resource Division in Colorado. The 3 sites are near the ABW or LMW (in addition to the 4 Yellowstone National Park sites) include Big Sky, Daisy Pass, and Lionshead). These sites will be sampled primarily with USGS staff and Gallatin NF personnel support. Chemical analysis (H^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, HN_4^+, SO_4+, NO_3-, and Cl-) is conducted by the USGS laboratory in Denver, Colorado with data analysis and reporting completed by USGS Water Resource Division in Colorado. Snowpack chemistry data and reports are available at the USGS web site at http://co.water.usgs.gov/Pubs/index.html#OFR

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